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WILD DUCKS AND DUCK FOODS OF THE BEAR RIVER MARSHES, UTAH.

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INTRODUCTION.

The economic value of wild ducks and geese as a source of sport, an incentive to healthful outdoor recreation, and an adjunct to the food supply is universally recognized in this country. Legislative measures for the protection of these birds, designed to enable them to hold their own against an ever-increasing army of gunners, have multiplied and have added to the restrictions on hunting as need for them has been realized by sportsmen and persons interested in birds in general. These regulations, however, have not been sufficient to maintain the birds in their former abundance. Regions that once were the summer homes of myriads of wild ducks have been drained and placed under cultivation, and extensive areas where the birds at one time bred are now populous farming communities. The changes have crowded out former avian residents and have served in a corresponding degree to reduce their numbers. Realization of these

NOTE.—This bulletin is a report on the abundance, food supplies, and general conditions affecting the wild ducks and geese breeding on the Bear River marshes in Utah, or frequenting this region at other times of the year, before their migrations to other parts of the United States. It is for the information of sportsmen and others interested in waterfowl.

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facts has led more recently to the adoption of other compensatory measures to encourage our larger waterfowl. A number of extensive marsh areas have been made permanent refuges under the guardianship of the United States Department of Agriculture, and many private preserves, some of them formed by artificial means, have been established, where the birds are protected while nesting and are shot under more or less rigid local restrictions during designated open seasons for hunting. As a means of cooperating in such efforts to maintain and increase the numbers of our waterfowl, the Biological Survey has undertaken investigations of the general conditions under which wild ducks live and thrive, coupled with counts of the numerical abundance of these birds in different areas varying in character. Much of this needed information has been gained through studies of the foods and general activities of our native wild ducks. Several bulletins dealing with favored duck foods that may be introduced or propagated in many areas where they are at present unknown have been issued,[1] and one enumerating the breeding ducks and the available duck foods of lakes in the sandhill region of Nebraska has been published.[2]

During three summer seasons the writer was engaged in field work dealing with wild ducks in the Bear River marshes in Utah, spending the greater part of the time from July 15 to October 23, 1914; May 18 to October 20, 1915; and May 15 to October 25, 1916, on this work. Extended observations and notes were made during the entire period, and in 1916 a count of the breeding ducks found in this area was made in as detailed a manner as practicable. In the following report is embodied a general account of observations and studies on the numbers and abundance of waterfowl, their food supplies, and the general conditions under which such birds live in that region.

GENERAL ACCOUNT OF THE BEAR RIVER MARSHES.

Bear River, the largest of the three main tributaries draining into Great Salt Lake, flows into the northern end of that body of water. Before reaching the saline waters of the lake proper the main stream of the river (Pl. I) breaks up into several branches, which in turn subdivide into minor channels, the whole forming a great delta embracing marshes grown with dense vegetation and open barrens of alkaline earth or mud. The silt-charged stream of the main river has filled in around its mouths, leaving two main lake

[1] McAtee, W. L., Eleven Important Wild-Duck Foods: U. S. Dept. Agr. Bull. 205, pp. 23, figs. 23, 1915; McAtee, W. L., Propagation of Wild-duck Foods: U. S. Dept. Agr. Bull. 465, pp. 40, figs. 35, 1917.

[2] Oberholser, Harry C., and W. L. McAtee, Waterfowl and Their Food Plants in the Sandhill Region of Nebraska: Part I, Waterfowl in Nebraska; Part II, Wild-duck Foods of the Sandhill Region of Nebraska: U. S. Dept. Agr. Bull. 794, pp. 77, pls. 5 (incl. 1 map), 1920.

areas, called respectively North Bay and South Bay, that open into the arm of the lake proper, known as Bear River Bay. Three main channels and one smaller one flow into North Bay and three overflows or branches supply South Bay. The space encompassed by these is wet and swampy. A large area known as Hansens Island, lying between the lower portions of the two bays, is cut by an old channel, formerly connected with the river but now separate, except where a canal (made by the Bear River Club in the fall of 1914) gives access to it. A series of lakes and sloughs, formerly parts of the river channel, lie parallel to Bear River from Corinne well down across the flats. Below these a large artificial lake, known as Chesapeake Bay, has been formed by damming Woods Creek. On the south side of the river below Brigham City is an extensive series of sloughs that drain into the Willard Spur, an arm of Bear River Bay. These are all included in the region covered by the following report. At the present time a large part of the water in Bear River is diverted during the summer season into irrigation canals, so that much of the water in the lower course of the stream comes from seepage and waste from the terminal ditches. North Bay receives water from the Malad River through a series of channels controlled by the Bear River Club, and in addition is augmented somewhat by drainage from the small streams known as Salt Creek and Blue Creek.

The entire area under consideration offers great inducements for waterfowl in the form of abundant food and attractive bodies of water. The banks of Bear River immediately below Corinne are cultivated, but along the lower course of the river, except in a few localities, the soil is little suited for farming, and there are few persons resident on it throughout the year. Near Corinne tree growths of box elder and cottonwood are found, but along the river below that point the main wooded growth is composed of black and gray willows (*Salix amygdaloides* and *Salix exigua*). These form a narrow band bordering either bank and extend down to the marshes. On either side are broad, level flats where alkaline conditions are too severe for much plant growth. These are bordered by extensive meadows of salt grass and are fringed with scattered plants of the curious fleshy-stemmed salt weed known as samphire.

DISCUSSION OF WATERFOWL.

BREEDING SPECIES AND THEIR ABUNDANCE.

Eleven species of ducks and the Canada goose are now known to nest on the Bear River marshes. Eight of the ducks are of common occurrence. Arranged in order of their abundance as breeding birds these are the redhead, cinnamon teal, mallard, shoveler or spoonbill,

gadwall, ruddy duck, pintail, and green-winged teal. The widgeon and blue-winged teal are only tolerably common, and the canvasback, a species that is decidedly rare in summer, is included on the authority of A. O. Treganza, of Salt Lake City; one additional species, the lesser scaup duck, is probably casual in its nesting here. On June 12, the writer, with his assistant, T. E. Griesa, found a male of this species near Long Point on North Bay. This bird passed and repassed a dozen times or more, circling about as ducks do when their nests are approached. Other scaup ducks were seen during the entire summer, but these birds remained in the open bays below the marshy areas and it was certain that they were nonbreeding individuals. It is a common thing for a few ducks of this species to pass the summer in regions far south of their breeding range, but in the instance mentioned there is little question that the male seen was a breeding bird.

In the enumeration of the breeding ducks of this area the entire region described under the general account of the Bear River marshes was covered as carefully as practicable between May 15 and June 26. Dependence was placed only in part upon birds seen in open water: each channel was traversed by boat or on foot, and extensive marsh areas were tramped in search for nests (Pl. II, fig. 1) or nesting birds. In some cases favorable localities were covered two or three times in order to check the results obtained. Ducks continue to breed until a much later date, but these delayed birds are probably those whose first nests have in some way been destroyed. Cinnamon teals only four or five days old were seen August 8, and redheads less than a third grown were common as late as September 7; a large number of young redheads were unable to fly until after September 25. An attempt to continue a count of the breeding ducks in this region after July 1, however would fail entirely to give an adequate conception of the number present earlier in the season.

The figures given in tabulating the final results of the counts are approximate: the enumerations were conservative, and it is believed that the results are sufficiently accurate, allowance being made for not more than 40 per cent of error. Greater accuracy can hardly be claimed in work of this sort except on small areas covered minutely. Ducks are adept at hiding, especially where vegetation is heavy, and often allow persons to pass within a few feet without flushing. Thus the examination of marsh areas through glasses from a distance is unsatisfactory, as many birds readily pass unnoticed. The results of the enumeration of breeding birds are given in the following table, the species being arranged in the order of their abundance:

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MAIN CHANNEL OF BEAR RIVER NEAR ITS MOUTH.

Marshy areas and alkaline flats are shown on either side and in the distance.

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FIG. 1.—NEST OF REDHEAD.

The redhead is the most common of breeding ducks in the Bear River marshes. This nest is about 18 inches high and has a pathway built up to one side.

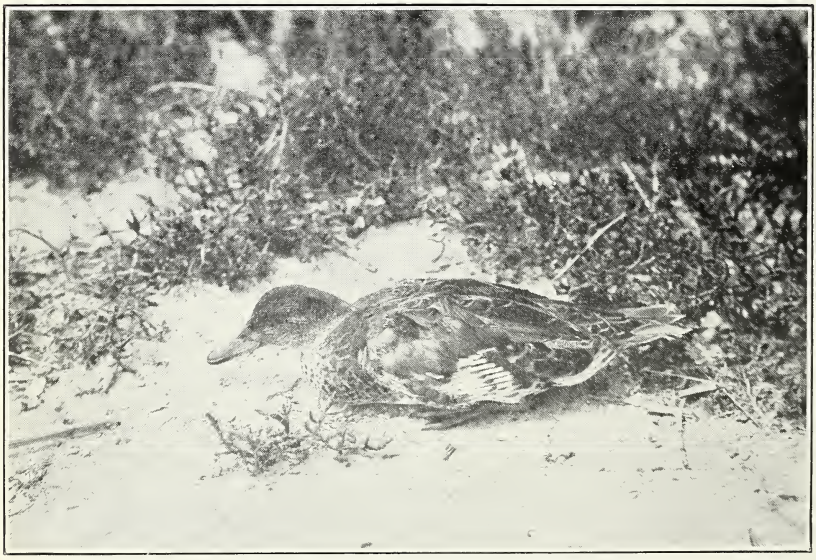

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FIG. 2.—GREEN-WINGED TEAL "FLAPPER."

A molting female, the new flight feathers reappearing to replace those dropped.

Species.	Estimated number of breeding pairs.	Species.	Estimated number of breeding pairs.
Redhead	1,725	Green-winged teal	50
Cinnamon teal	800	Widgeon	10
Mallard	300	Blue-winged teal	10
Shoveler, or spoonbill	250	Scaup duck, or bluebill	[1] 1
Gadwall	200		
Ruddy duck	175	Total	3,650
Pintail	130		

[1] Not included in total.

As a conservative estimate each pair of ducks may be expected to rear 5 young, and as the average brood varies from 7 to 12 individuals this allows for considerable mortality among ducklings. Adding the survivors to the original pair, the total number of native birds on this marsh at the end of the breeding season should be approximately as follows:

Species.	Individuals.	Species.	Individuals.
Redhead	12,075	Pintail	910
Cinnamon teal	5,600	Green-winged teal	350
Mallard	2,100	Widgeon	70
Shoveler, or spoonbill	1,750	Blue-winged teal	70
Gadwall	1,400		
Ruddy duck	1,225	Total	25,550

In addition to the ducks, about 100 pairs of Canada geese breed on these marshes. Allowing 3 young as the average number brought to maturity by this species, there would be a total of 500 birds at the close of the season. The nesting season for these geese is practically over by May 15, and their numbers were estimated from observations made before they disappeared in the lower marshes for their annual molt.

The figures given above are approximations, but it is believed that they are not far from the truth. From them it is learned that this marsh area produces between 25,000 and 30,000 ducks in the average season, as in 1916. The question may arise as to the propriety, in arriving at a total, of adding the original pair of birds to the young produced. It is probable that a large part of the adult ducks that die from natural causes (as opposed to shooting) do so toward the close of the breeding season and during the molt that follows. Exhausted by the calls made upon their strength by the needs of the nesting season, they have not sufficient vitality to carry them through the annual molt that takes place as soon as they are freed from their parental duties. In the estimates, however, sufficient allowance has been made for mortality among the young to cover losses among the adults as well, so that the totals given should

represent the actual number of birds produced from this marsh that are available to sportsmen there and elsewhere.

HABITS AND ACTIVITIES AFTER THE NESTING SEASON.

In the course of studies in this region it was learned that the great marshes in the delta of Bear River not only offer a favorable breeding ground for many pairs of ducks, but also that they are even more important as a refuge and feeding ground for a much larger number of birds after these are freed from family cares in other regions. To maintain themselves in condition, all species of birds must renew their bodily covering of feathers at least once each year, while many forms molt partially or entirely at shorter intervals. This usually is a gradual process, as only a few feathers drop out at one time and are replaced by new ones. One or two feathers fall in either wing at approximately the same time and more are not lost until the first ones are partly grown. By this continuous renewal the powers of flight of the ordinary bird are not seriously hampered and it is able to feed, fly about, and evade its enemies as usual.

In wild ducks and geese, however, the process is entirely different. In common with grebes and rails, the ducks and other anserine birds drop all the feathers of the wings and tail at about the same time, and for a period of four or five weeks are wholly unable to fly. At this time they must have access to large marsh areas where they may find an abundance of food without exposing themselves unduly to the attacks of enemies. Many thousand ducks from other areas gather in the Bear River marshes each season for this purpose, greatly augmenting the numbers of those that breed there.

In all the species of ducks that frequent this area in summer, except the ruddy duck, the males nearly always desert their mates as soon as the complete set of eggs has been deposited and incubation has begun. During three summers spent on Bear River the writer saw many hundreds of broods of wild ducks, but, except in the case of ruddy ducks, not more than ten instances were observed where drakes accompanied the young. The male ruddy duck, like the Canada goose, usually stays with the female until the ducklings are well grown, and it is common to see one at the head of a brood of dusky young, swimming with chest and neck puffed out and tail spread. Occasionally a male gadwall, shoveler, or mallard may accompany a female and her brood, but such occurrences are rare.

After the pairing season the drakes begin to join in flocks, and large bands of these males gather to feed and rest on the great open bays. At this time they are in bright, showy plumage, but early in summer a change takes place. The body feathers are replaced by a plain dull plumage more or less resembling that of the female,

and entirely different from the winter dress. This is known as the "eclipse" plumage and is found in all of the ducks that occur here except the ruddy duck. Soon after going into the eclipse plumage the drakes drop their wing and tail feathers, and then hide in the marsh growth until again able to fly. So well do they keep concealed that they are seldom seen, and few local sportsmen or others are acquainted with this peculiar habit, while persons who may happen to see them usually consider them young birds because of their bare wings. Ducks in this flightless condition are known as "flappers." In working through the marshes they may be heard quacking and feeding in every direction, and if one is startled it flaps off at a rapid rate and hides so well that it can not be found. At night they come out to feed in the bays and lakes, but retreat again to the shelter of the rushes at daybreak. Most female ducks are busied with their young during the period that the males are molting into the eclipse plumage, but soon after the ducklings can care for themselves, the females join the other ducks in the bays and in turn soon shed their flight feathers. (Pl. II, fig. 2.) Most of the female ducks are later in their molt than the males, and in the case of birds whose first nest is destroyed so that they rear a second brood the molt may be delayed until late in summer or early in fall. Individuals late in molting may be found commonly in the Bear River marshes through the month of September and many are still in this condition after the opening of the hunting season on October 1.

In September the drakes begin to molt their body plumage again and come out in the bright-colored dress by which they are known in winter and spring. Sportsmen often ask why more old drakes are not shot at the beginning of the hunting season. The apparent lack of old males is due to the fact that they are confused with the immature birds from their piebald, patchy appearance as they change from the eclipse dress into full plumage. Adult female ducks, especially of pintails and green-winged teals, killed during the first half of October, nearly always have many pin feathers coming in on the body, due to their late molt as compared with the drakes. This fact is often remarked by the duck pickers who pluck the thousands of birds brought in to the gun clubs, and has been verified by the writer from personal observation of many hundreds of ducks.

From the foregoing it may be seen that while the delta of Bear River furnishes a breeding ground for many waterfowl, it is of even greater importance as a refuge during their annual molt to other individuals that have nested at unknown distances from the marsh. The drakes begin to come in for this purpose early in the season, the male pintails being the first to make their appearance in numbers. On June 14, 1915, a flock of 500 was found at the upper

end of South Bay, and a week later there were many hundreds. Birds that were shot for examination had the genital organs greatly enlarged, showing that they had finished breeding recently. They began molting into the eclipse plumage at once, and the mud flats where they rested during the day were strewn with cast-off feathers. In 1916 pintails appeared even earlier in the season; on June 7 about 100 drakes were found in South Bay, while on the following day their numbers had been augmented to approximately 1,000. On June 14 a flock of male pintails in the region known as Lands End was estimated to contain between 2,500 and 3,000 birds. With these were only two or three females. As it was estimated that in 1916 there were only 130 pairs of breeding pintails in this entire marsh area, it will be seen that there was a great influx of males at this time. Where these summering birds nest is of course uncertain, but they must gather here from great areas that apparently lie largely outside of Utah. Though the pintails arrive first, they are soon joined by many mallards and shovelers, of which a part come from the surrounding marsh and a part from other regions. These males steadily increase in number and, joined later by broods of immature birds, form great banks of ducks that rest during the day on the shallows covering the mud flats.

The Canada geese follow a different procedure in their molt. They nest early, and as soon as their young are strong enough they take them far down on the flats. The adult birds are more or less in evidence until about May 25, when most of them disappear. At this season adults and young frequent the great growths of rushes (*Scirpus paludosus*) in the lower marsh, and while hidden here the adults molt their flight feathers. In 1916 a number of families of geese lived in the lower part of Hansens Island through this period of molt. In feeding they apparently ranged over considerable areas and at night came into dense green rush growths near the open bays, where they slept close together on small hummocks. At this season they were warier than ever and seldom was one seen. In the heavy growths of rushes their roosting places, marked by broken, trampled vegetation and great piles of excreta, were found frequently; and goose tracks were often seen in small channels and runs through the marsh, so fresh that mud stirred up as the geese passed was still held in suspension in the water, but the birds themselves kept well hidden. By molting at this early date the wing feathers of the adults were renewed by the time the young were able to fly, and old and young were thus able to remain together. Geese begin to reappear on the marsh between July 1 and 4, and by July 10 small flocks with their musical call notes were again a familiar morning and evening feature of the life of the marsh.

FALL MIGRATION.

The number of wild ducks on the Bear River marshes continues to grow until about the 1st of September; during the latter part of August the increase is rapid, as hordes of young ducks that have been reared on the uplands and along small streams and lakes in the mountain valleys begin to arrive. Between the 1st and the 10th of September there is a sudden diminution in the numbers, and at this time fully two-thirds of the ducks leave the marsh and migrate to other regions, apparently far distant. The great mass of cinnamon teals and redheads leave the marsh then and with them go many pintails and others. The sudden disappearance of numbers of the ducks is noticeable, and can not fail to attract the attention of one closely in touch with the daily course of the wild life on the marsh. The exodus seems to take place at night, and bays and lagoons that one day are banked solidly with rank after rank of resting waterfowl may 24 hours later show individuals only in tens where before they were represented in hundreds. That this migration is to distant points seems certain. A drake pintail that had been banded and released at a field laboratory near the Duckville Gun Club on these marshes September 4, 1916, was killed 11 days later not far from Glasgow, Mont.

Ducks again begin to gather on the flats, however, and by the opening of the hunting season enormous numbers are once more present. These are composed of young birds and adults that have come in from other regions, of young from late-hatched broods on these marshes, and of adults that after completing the molt have come out from the seclusion of the rushes. There is considerable movement night and morning among these birds, but they have no such regularly established lines of flight at this time as they do after two or three days of shooting. From October 8 to 15 many additional ducks come in from the north, their arrival depending upon cold storms that drive them from more northern localities. From this time on the migration from the north is steady. Several species arrive that are rare or absent during the breeding season and so add to the duck population of the marsh. The canvas-back is fairly common after October 10, while the snow goose, buffle-head, and golden-eye, or whistler, are present in some numbers after October 15. Lesser scaup ducks, or bluebills, come at about the same time, but are not common until a week later. Besides these a few other species appear in very small numbers. The ducks are said to remain in fall as long as there is open water in the channels or bays, but most of them are reported to leave finally between December 1 and 15. The date of departure varies with the year and may be earlier or later, according to the season.

THE SHOOTING SEASON.

By referring to the list of breeding ducks given on page 5, it will be seen that redheads and cinnamon teals comprise more than two-thirds of the total number of ducks that breed on the Bear River marshes; those familiar with conditions during the hunting season, however, recognize that these two species furnish a very small percentage of the ducks that are killed each fall. The bulk of the redheads leave as soon as the adult ducks have completed their molt and are able to fly, and by September 15 the greater part of them are gone. Most of the cinnamon teals leave at the same time and few of these are killed. The birds that remain during the hunting season are immature birds from late broods, unable to fly at the time of the great migration of their fellows. These stay until late in the season and may be present until the bays are closed by ice. The early migration of these ducks has been used by a few as an argument for opening the hunting season during part or all of the month of September. To make the opening date earlier than October 1, however, would be a great mistake, as it would inevitably lead to killing a large number of young ducks before they are in condition, while at the same time many of the adult birds would be molting and so would not offer sport or be of much value as food. It is fortunate that the majority realize this and are content with present conditions.

FOOD SUPPLIES ATTRACTIVE TO WILD DUCKS.

In order to attract and support a large number of wild ducks, a marsh area, besides affording a retreat from enemies, must offer an abundant store of food. If attractive food supplies are available, ducks will gather and linger in spite of shooting and other disturbances. In the Bear River marshes the two prime requirements of food and shelter are met to the fullest degree. The areas of marsh and open bay are broad enough to harbor a large number of birds in comparative safety and to allow them to shift from place to place when disturbed, while the food supplies apparently are boundless. Collections of plants and seeds were made here during three seasons and those foods that have been found attractive to wild ducks through observations made in the field, supplemented by the examination of stomachs of birds killed in the marshes, are enumerated in the following paragraphs.

VEGETABLE FOODS.

There are two plants present in great abundance in the area under consideration upon which ducks depend largely for their staple vegetable food—the sago pondweed and the bayonet grass. Sago pond-

weed (*Potamogeton pectinatus*), known familiarly to hunters as "potato moss" or "duck moss," is the dominant plant of the open bays and sloughs, where it grows submerged in the water. This plant springs from a tuber buried from a few inches to a foot or more in the mud. It appears in the bays in abundance during the last part of May and by the end of June has filled the greater part of the open water with dense growth. During July it produces a mass of hard seeds, and then a great deal of it dies down in the bays at the mouth of the river and breaks off at the roots, to drift out into the lake and leave the bays bare open expanses with a smooth mud bottom. In other places, as the Chesapeake Bay, the summer growth sinks to the bottom and remains throughout the fall. The sago pondweed is one of the best of known duck foods, as all parts of the plant, the tubers, stems, leaves, and seeds are palatable and are eagerly sought as food by wild ducks. The ducks dig great "duck holes" in the mud of the open bay from 1 to 20 or 30 feet wide and from a few inches to a foot deep, in search of the succulent tubers. These roots furnish a great part of the food of the pintails and mallards on the marsh in fall and are eaten eagerly by most if not all of the other ducks. In summer and early fall the stems and leaves also are sought.

Sago pondweed seems to be strongly resistant to the action of alkalis, as it will grow in areas where the soil is impregnated with salts, though in such places the growth of the plant may be somewhat stunted. This plant also thrives in the fresher water of channels and sloughs, and here makes a very heavy growth. Its tubers are frequently as large as a kernel of corn, and, if the sprout is discarded, they have a pleasant, nutlike flavor. They persist even during years when the bays are dry during summer, and so insure a supply of this food the following year. After the plants have died down in the lower bay the seeds still remain, and often are washed up in long windrows on the mud bars. Green-winged teals as well as other ducks are fond of these, and in fact hardly a duck stomach was examined in late summer and fall that did not contain a few of them. Bits of gravel or other hard particles are essential to digestion of food in ducks, but in alluvial deposits like those at the mouth of Bear River, situated far from the foothills, small pebbles and grit are difficult to secure. The hard seeds of the "potato moss" are firm enough to aid in grinding up other softer foods, while at the same time they are themselves digested, so that they serve a double purpose in the economy of the birds concerned.

The second plant, equal in importance as a duck food to the one just described, is the bayonet grass, rush, or tule (*Scirpus paludosus*). (Pl. III, fig. 1.) This is the dominant plant of the marsh growth and, except where saline conditions in the soil are too strong, covers the

entire marsh. It grows usually to a height of from 18 inches to 2 feet or more, according to the locality. The plant has a three-sided stem, from which sheathlike leaves spring at different levels, and it grows from a bulb as large as a walnut. The head bears from 6 to 20 or more ovate, flat brown or blackish seeds with sharp, pointed tips. These seeds begin to mature in July and August and are a favorite food of ducks, especially of those species known as the shallow-water or river ducks. The stems of the tules themselves are used by hunters in building blinds. During late summer these growths of rushes furnish much of the cover that protects the waterfowl during the molt and later the ducks visit them for food. Most duck stomachs examined contained from one to many of the seeds of this plant.

Bayonet grass is of great importance as a food supply, as, though many of the seeds drop to the ground in fall, a good proportion remain in the seed heads until the following year and persist in abundance as late as May and the first part of June. In this way they furnish a food supply late in fall when other stocks are sealed with ice, and in spring these seeds again are available to the ducks returning from the south.

Other plants, also present in abundance, furnish valuable foods for ducks. Samphire or salicornia (*Salicornia rubra*) covers great areas of otherwise barren flats, and in less saline soils a saltbush known as lamb's-quarters, or duck lettuce (*Atriplex hastata*), is abundant. In fall the ducks eat the fleshy leaves and stems of these plants to a considerable extent. The seeds of a dock (*Rumex crispus*) are relished, as are the seed heads of the abundant salt grass (*Distichlis spicata*). In very saline waters a musk grass (*Chara* sp.) and ditch grass (*Ruppia occidentalis*), both favored duck foods, are common, and there are a number of other species of plants whose seeds, leaves, or stems are relished which are likewise common though less abundant than those enumerated above.

A complete list of the plants available as duck foods in this area, with some indication of their occurrence, follows:

Species Growing Submerged.

Sago pondweed (*Potamogeton pectinatus*). Abundant.
Ditch grass (*Ruppia occidentalis*). Common.
Musk grass (*Chara* sp.). Common.
Long-leaved pondweed (*Potamogeton americanus*). Common near Corinne.

Floating Plants.

Duckweed (*Lemna* sp.). Fairly common in fresh water.
Water smartweed (*Polygonum amphibium*). Fairly common.
White water crowfoot (*Batrachium trichophyllum*). Fairly common.

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FIG. 1.—TYPICAL MARSH GROWTH OF TULE, OR BAYONET GRASS (SCIRPUS PALUDOSUS).

The seeds of this plant furnish a valuable food for wild ducks.

B17155

FIG. 2.—GROWTH OF CANE (PHRAGMITES PHRAGMITES).

These plants furnish cover for ducks and their young and are used also by sportsmen in constructing boat blinds during the hunting season.

B17156

ONE OF THE LARGER BRANCHES INTO WHICH BEAR RIVER DIVIDES AT ITS MOUTH.

Typical vegetation—black willow (*Salix amygdaloides*) on left, and broad-leaved cat-tail (*Typha latifolia*) on right.

SHORE AND MARSH PLANTS.

Bayonet grass (*Scirpus paludosus*). Abundant.
Bulrush, round tule (*Scirpus occidentalis*). Common.
Olney bulrush (*Scirpus olneyi*). Common in the Salt Creek marsh.
Wire grass (*Eleocharis palustris*). Locally common.
Bur reed (*Sparganium eurycarpum*). Fairly common.
Arrow-grass (*Triglochin maritima*). Common.
Rush grass (*Sporobolus airoides*). Common.
Beard grass (*Polypogon monspeliensis*). Common.
Bent grass (*Agrostis alba*). Common.
Cord grass (*Spartina gracilis*). Fairly common.
Slough grass (*Beckmannia erucaeformis*). Fairly common.
Salt grass (*Distichlis spicata*). Abundant.
Goose grass (*Puccinellia nuttalliana*). Fairly common.
Brome grass (*Bromus tectorum*). Fairly common.
Foxtail (*Hordeum jubatum*). Abundant.
Wild barley (*Hordeum cussoneanum*). Fairly common.
Wild rye (*Elymus condensatus*). Fairly common.
Bog rush (*Juncus torreyi*). Fairly common.
Dock (*Rumex crispus*). Common.
Knotweed (*Polygonum incarnatum*). Fairly common.
Knot grass (*Polygonum aviculare*). Fairly common.
Burro weed (*Allenrolfea occidentalis*). Common.
Samphire (*Salicornia rubra*). Abundant.
Utah samphire (*Salicornia utahensis*). Common.
Salt bush, orache (*Atriplex hastata*). Abundant.
Goosefoot (*Dondia erecta*). Common.
Sandwort (*Tissa sparsifolia*). Common.
Buttercup (*Ranunculus eremogenes*). Common.
Trailing buttercup (*Halerpestes cymbalaria*). Common.
Yellow cress (*Radicula hispida*). Common.
White sweet clover. (*Melilotus alba*). Common.
Yellow sweet clover (*Melilotus officinalis*). Common.
Willow herb (*Epilobium adenocaulon*). Common.
Black saltwort (*Glaux maritima*). Common.
Heliotrope (*Heliotropium xerophilum*). Common.
Germander (*Teucrium occidentalis*). Common.
Mint (*Mentha penardi*). Common.
Cocklebur (*Xanthium echinatum*). Common.
Sunflower (*Helianthus nuttalli*). Common.
Pitchfork (*Bidens glaucescens*). Common.
Wild lettuce (*Lactuca integrata*). Common.
Blue lettuce (*Lactuca pulchella*). Common.
Spring sow thistle (*Sonchus asper*). Common.

All the plants enumerated contribute more or less to the food of the wild ducks in the marshes under consideration. There are in addition other plant growths present that, while not of value for their production of food, are abundant enough to serve as cover plants that furnish shelter and protection. Among these may be mentioned the broad-leaved and narrow-leaved cat-tails (*Typha latifolia* and *Typha angustifolia*), cane (*Phragmites phragmites*), gray willow

(*Salix exigua*), and black willow (*Salix amygdaloides*). (Pl. III, fig. 2, and Pl. IV.)

It is thus evident that the conditions found in the Bear River marshes leave little to be desired in the way of duck-food plants. In other regions improvement frequently may be brought about by introducing suitable plants for cover and for additional food supply. These marshes are so favored that artificial introduction of plants would not seem to be needed.

Among plants not found there, but considered valuable duck foods and possible of introduction, is wild celery (*Vallisneria spiralis*), as this plant can grow in brackish water. Whether such introduction would be successful can be ascertained only by experiment. This plant grows submerged and to thrive would require the deeper situations, as in certain channels in the upper sloughs, or in the Chesapeake Bay. Wild rice (*Zizania palustris*), the only other plant of importance that might be considered, can not endure salt to any extent, so that the alkaline waters and soils of Bear River would preclude its successful introduction, except possibly in certain small, restricted areas. In the long run, without much doubt, it will be found that the present marsh vegetation is best suited to these extensive flats. Soil conditions, as regards alkalinity, change and shift annually with changes in the water level of the lake itself, and with the volume of stream flow in Bear River. The marsh vegetation advances and retreats year by year, adjusting itself according to certain limits of tolerance for alkalis, in one place extending its bounds and in another being killed out and forced to withdraw. At present the tendency is for the tule growth in the lower part of the marsh to be driven back, while extensive flats above the true marshes, that in 1914 were open alkaline barrens, in 1915 and 1916 were covered with a luxuriant growth of salt grass. Masses of submerged tule roots to be found downstream several miles below the present living growth attest the former limits of the marsh vegetation. Holes dug to a depth of 2 or 3 feet at various places on the marsh often showed a narrow layer of black soil containing remains of *Scirpus* stems and root bulbs beneath a layer of barren clay 18 or 20 inches thick, indicating an ancient marsh area, long ago entirely killed out and submerged. It is doubtful whether introduced plants from regions where the struggle for existence is less keen would be able to adapt themselves to such frequent shifts and changes in environment.

ANIMAL FOODS.

Though most of the ducks found on the Bear River marshes draw their staple food supply from seeds, tubers, or other vegetable matter, there are certain animal foods in this area that are of sufficient

importance to merit attention. Any of the ducks will turn to animal matter for sustenance when it is readily available and snap up insects or even small minnows that may be accessible, though normally the bulk of their food may be vegetable matter. There are, however, at the mouth of Bear River, a few species belonging to the animal kingdom present in such numbers as to form a food supply upon which some ducks feed to large extent during part of the year. Below the lower end of the marsh, where saline conditions are so pronounced as to prevent vegetable growth, are great quantities of the immature stages of several species of alkali flies (*Ephydra hians*, *E. subopaca*, and *E. gracilis*). The larvæ and pupæ of these insects form great masses in the water and the cast-off pupal cases are washed up in windrows that frequently extend for miles along the shores of the lake. With them in equal numbers, or possibly exceeding them in abundance, are the fairy or brine shrimps (*Artemia fertilis*). These small, almost transparent creatures are so abundant that they form veritable clouds in the water, and these, with the fly larvæ and pupæ, form an important source of food for certain species of ducks and also for various shorebirds.[3] After the summer molt spoonbills, or shovelers, begin to gather in the lower bays, and by September 1 are present in considerable numbers. The flocks continue to increase, until by October 1 it is not unusual to see close banks of these birds 2 miles or more long and from a fourth to half a mile deep. At this time the birds feed largely on the brine shrimps and on alkali-fly larvæ and pupæ. They remain here until finally driven out by the freezing of the fresh-water bays, to which they resort to drink. Usually the shoveler is thin and poor in body, but birds killed here were exceedingly fat, so that while this species ordinarily is considered a mediocre table bird, those killed on the lower bays were good eating.

During October the spoonbills were joined by great flocks of lesser scaup ducks (*Marila affinis*) and later by a considerable number of golden-eyes, or whistlers (*Clangula clangula americana*), and all subsisted largely upon the brine shrimps and the immature alkali flies. These ducks were found regularly only in this part of the bay and it was unusual to see them higher up. Ducks shot in this lower area often were crammed with food, so that when the birds were picked up by the feet brine shrimps and fly larvæ oozed in a slimy mass from their throats. It is hardly necessary to point out the value of these supplies of animal food as an additional attraction to bring wild ducks to this marsh.

[3] Cf. Wetmore, A., On the Fauna of Great Salt Lake: Amer. Naturalist, vol. 51, pp. 753–755, 1917.

OTHER CONDITIONS AFFECTING WATERFOWL.

AGRICULTURAL OPERATIONS.

It has been said in the foregoing that the supplies of seeds carried over winter in the fruiting heads of the bayonet grass, or tule, are of importance as food for the wild ducks returning from the South in spring. As these seeds are available practically throughout the year they furnish a valuable source of sustenance. The burning of large areas, therefore, to clear the marsh or to induce a fresh clean growth for ranging purposes is to be frowned upon, as it tends to destroy a certain proportion of the available stock of duck food. Many of the seeds are charred and destroyed by the flames, and though a part are not seriously harmed a large proportion of the stock is liable to be washed away and lost during the high water incident to the breaking up of the winter covering of ice in spring, and the subsequent floods due to melting snows in the foothills. While the practice of burning clears the marsh, it also destroys mats and tangles of dead vegetation that in many cases form necessary shelters for the breeding ducks, insuring the successful hiding of their nests and later protecting the young until they are strong enough to venture into the open.

A practice that is almost equally injurious is that of mowing certain areas along the banks of the river and the larger overflows in order to put up wild hay. It is of course unavoidable that many ducks' nests are destroyed in the alfalfa and hay fields in the uplands, as these areas produce valuable crops. Where Bear River breaks up into overflows near its mouth there is a narrow band of sweet clover, salt grass, and foxtail along the banks that is sometimes harvested with mowing machines. Where this is done before July 20, a considerable number of ducks' nests are uncovered or destroyed, and in some cases the ducks themselves are maimed or killed. Nests exposed in the open are in a majority of cases rifled by magpies, coyotes, or other enemies and so are destroyed. The cinnamon teal and gadwall nest commonly in these areas, and in this way are injured frequently. Where mowing is necessary it should be done after July 20, if possible, and in any case the vegetation bordering the channels should be left untouched. Comparatively few of the ducks that nest here locate their nests farther than 100 feet from the water's edge, and by mowing outside this limit only an occasional brood will be destroyed.

NATURAL ENEMIES.

Magpies.—The ducks in the area under consideration are not without natural enemies. Among these the magpie is perhaps the most common, though it is restricted in its range to the immediate vicinity of the narrow band of willows that lines the river bank and

the shores of some of the larger overflows. The depredations of these birds are confined almost entirely to pilfering eggs from the nests, though occasionally they may kill newly hatched ducklings. In a number of places the writer observed ducks' nests that had been broken up by magpies during 1915 and 1916. This was especially the case with nests exposed during haying operations. There is no question that magpies, finding conditions here favorable to their increase, have multiplied to a point where they are directly injurious to other more valuable species. It is a comparatively simple matter to limit their numbers by means of poisoned baits properly used. Under proper conditions one man should be able to reduce them to the desired minimum in two or three weeks' work.[4] It is neither necessary nor profitable to carry poisoning operations far enough to exterminate the birds, but merely to control them to the point of eliminating a large part of the damage.

Gulls.—Ring-billed and California gulls do not appear to harm the ducks during the breeding season, but during the fall kill a good many that are helpless with the duck sickness. Ravens do a certain amount of damage in the same way, but are not common enough to be considered definitely destructive. The case of the gulls is somewhat different, as these birds are abundant and often are present in large flocks. During the shooting season gulls also attack ducks that have been killed by hunters and, not content with eating from one bird, often pick and tear open several, taking only a small portion of flesh from each. From observation it has developed that certain birds may become addicted to this practice, and it is an open question whether these individuals should be killed to prevent such unwarranted destruction.

Other birds.—Among bird enemies that have not been mentioned are the duck hawks, which take occasional toll, and the black-crowned night heron, which at times eats young ducklings. The ducks destroyed by these two are, however, a negligible quantity and do not warrant the persecution of these birds.

Coyotes.—The coyote is another enemy of the ducks and destroys a considerable number each year. In the delta region of the river these mammals occur during the summer, but do not become common until the middle of August or the first of September, at which time their tracks may be found in abundance. They work through the marshes in search of young ducks and "flappers" and also follow the borders of the bays to secure birds suffering from the duck sickness that has come into prominence here during recent years.[5] Many

[4] Those interested may obtain instructions for preparing properly poisoned baits by writing to the Biological Survey, Washington, D. C.

[5] Cf. Wetmore, Alexander, The Duck Sickness in Utah: U. S. Dept. Agr. Bull. 672, pp. 25, pls. 4, 1918.

birds suffering from this malady manage to crawl out of the water and take refuge in the vegetation, where they lie frequently for several days in a more or less helpless condition. Where coyotes are numerous a large proportion of these ducks are captured and eaten. As many of them, if not molested, would recover, considerable destruction is thus wrought by the coyotes. During three seasons' work the writer has seen where several hundred of these sick ducks were killed and eaten by these animals.

Other mammals.—In some parts of the marsh many domestic cats run wild and not only destroy numbers of young ducks, but also, strange as it may seem, a fair proportion of fully grown ones. Haunts of these cats found in the rushes were strewn with ducks' feathers and bones. A few skunks are found on the marshes, but minks are very rare. Some have thought that the porcupines that wander down here from the mountains in fall feed upon birds, but this is entirely without basis, as the porcupine is vegetarian in its feeding habits.

Hogs ranging in the marsh at any season would inevitably cause great damage by destroying nests and young and by rooting out the marsh vegetation. In September, 1916, a drove of hogs made their way down the river to the region at the mouth of Browns Overflow and fed there for several days before they were driven out. At that time there were many sick ducks in this area, and numbers of the helpless birds were lying concealed in the marshy growth lining the shore. General conditions at the time were such that if unmolested a large proportion of these birds would have recovered, but as it happened several hundred ducks were killed and eaten by hogs. This is only an instance of the damage that may result from such invasion, and all measures should be taken to prevent stocking the marsh with hogs. Damage to marsh vegetation by these animals may be seen in the marshes at Locomotive Springs, near Kelton, where large areas of *Scirpus* have been rooted out.

Fish.—Carp have been introduced in Bear River and are enormously abundant in the marsh region in the delta. In summer they frequent the open bays in great droves and do a certain amount of damage by digging out the growths of sago pondweed. The quantity destroyed is not now excessive, but it might easily become so if measures were not taken to keep down the increase of these fish.

CONCLUSION.

During three seasons devoted to field work, eleven species of ducks and the Canada goose were found breeding in the region included in the Bear River marshes. This covers an extensive area in the Salt Lake Valley, Utah, lying in the delta of Bear River and extending inland to the sloughs west of Corinne and below Brigham.

In a conservative enumeration made during May and June, 1916, of the eleven species of breeding ducks, 3,650 pairs were counted, and it is believed that this number represents between 60 and 100 per cent of the total number of breeding ducks occurring there that season. Allowing 5 young reared to maturity as the average for each pair, and considering 1916 as an average season, it may be stated that between 25,000 and 30,000 wild ducks native to the marsh are to be found there at the close of the breeding period.

In addition, a large number of other ducks come in after the nesting season in order to molt, and, after renewing their feathers, to rest in the shelter of the marshes until fall. These nonbreeding birds appear during the first part of June and are present in large numbers by the first of July. They increase through July and August, but during the first week in September a large proportion migrate to other regions. Other ducks continue to come in from the north, however, and by the opening of the hunting season on October 1, a full complement again is present.

Of the duck foods attractive to these birds, two plants, the sago pondweed and the tule, or bayonet grass, both occurring in abundance, furnish a large part of the vegetable portion; in all, 49 plants were found available as duck foods. In addition, the brine shrimp and the immature stages of the alkali flies, both of which swarm in the salt water below the marsh, are relished by certain ducks. Though in other localities it has been possible in many instances to add certain growths to the species already present, the food plants occurring on the Bear River marshes seem to comprise the most valuable of those capable of being propagated under the prevailing alkaline conditions of soil and water. Wild celery might form a useful addition, but its introduction would be in the nature of an experiment.

The practice of burning the marsh in fall and winter destroys the seeds held in the seed heads of the tules, a valuable supply of food available to the ducks when they return to the marsh in spring. Cutting wild hay along the banks of the river and the larger overflows before July 20 lays nests open to attack or may destroy them, together with the brooding birds. This damage would be obviated if haying were begun later, or if a strip at least 100 feet wide were left uncut along the stream banks. These measures should be taken where possible. Among other factors contributing to the destruction of ducks may be mentioned magpies, coyotes, and the domestic cats which run wild on the marsh, and California and ring-billed gulls. The gulls kill many ducks helpless from the duck sickness that otherwise might recover, and in addition are more or less of a nuisance in the shooting season, as they attack and mutilate many ducks that have been killed by hunters.

In general, it may be said that conditions on the Bear River marshes are favorable for the attraction and preservation of a large number of wild ducks. This area may be likened to the lower end of a great funnel, that, drawing its supply of waterfowl from Salt Lake Valley and also from a broad area to the north, concentrates the birds here until they spread in migration to other regions of the West. That these birds do range widely after leaving these marshes has been shown by records of ducks that have been banded and released here and subsequently have been shot elsewhere.[6] Records thus obtained show that birds released near the mouth of Bear River in migration cover the region from Oklahoma and Texas west to the Pacific coast in California.

[6] During an investigation of the duck sickness mentioned as occurring on these marshes, a considerable number of ducks were banded and released. The aluminum bands used are placed securely on the legs of the ducks. These bands are of two types, each bearing a number on one side; the reverse in one style is inscribed "Notify U. S. Dept. Agr., Wash., D. C.," and in the other, "Notify Biological Survey, Washington, D. C." It is hoped that sportsmen killing ducks marked in this way will forward the bands at once as directed, with information as to date and place of capture and any other details that seem relevant. Valuable information is available from such return records as to lines of migration, longevity of individual birds, and other points of value in study of conditions affecting waterfowl.

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